

HIGH-TEMPERATURE VAPORIZATION OF METEORITES. Yu.P.Dikov¹, M.V.Gerasimov², F.Wlotzka⁴, O.I.Yakovlev³. Russian Academy of Sci.: 1- Inst. of Ore Deposits, Petrography, Mineralogy and Geochemistry; 2- Space Research Inst., Profsoyuznaya st., 84/32, Moscow, 117810, mgerasim@mx.iki.rssi.ru; 3- Vernadsky Inst. of Geochem. and Analytical Chemistry; Moscow, Russia; and 4- Max-Planck-Inst. für Chemie, Mainz, F.R.Germany.

In this set of experiments we have investigated the chemical composition of condensates and melts which were produced during high-temperature (4000-5000 K) pulse vaporization of some ordinary and carbonaceous chondrites. It was shown that there is a noticeable change in (Mg+Fe)/Si and Mg/Si ratios in the condensate and in the melt providing condensates of pyroxene composition. Chemical composition of the melt is ranging between olivine and pyroxene composition with a certain portion of Fe being extracted into metallic spherules.

In the previous study [1,2] we have investigated the differentiation of Mg- and Fe-Mg- silicates during high-temperature vaporization. The problem is connected with the problem of differentiation of silicates during impacts and resulting early impact-induced differentiation of planetary matter. The aim of the previous study was to investigate experimentally the trends of differentiation of Mg- and Fe-Mg- ultramafic and mafic silicates under simulated impact vaporization conditions. The main result of cited experiments was the transformation of ultramafic silicates (olivine and serpentine) to condensates of mafic composition (ortopyroxene) during high-temperature evaporation. In the new set of experiments we have investigated high-temperature vaporization trends of meteorites since their matter is the most reliable model of planetesimals. No data exist on evaporative behavior of meteorites in a temperature range around 4000-5000 K.

Experimental procedure was the same as in [1]. High temperature vaporization was provided using a neodymium glass powerful pulse laser. A sample was placed in a hermetic cell with a volume of ~500 cm³. A beam of unmodulated laser pulse was focused through an optical window on the sample surface. The luminous energy output of the laser pulse was ranged from 400 to 600 J. Duration of laser pulse was ~10⁻³ sec. By adjusting of

beam fingerprint on sample's surface in a spot with diameter from 2 to 5 mm we could vary the density of luminosity of laser pulse in a range 2x10⁶-2x10⁷ W/cm². During one pulse about 10 to 20 mg of a sample was vaporized producing a crater 3-8 mm in diameter with a residue melt inside. Vaporization of samples was performed in different gas environments. Pressure inside the cell was 1 atm. Some experiments were performed in helium to provide evaporation in inert environment, some other experiments were performed in CO₂ which could be saturated by H₂O vapor to model evaporation in possible atmospheric conditions. At a distance of 5-6 cm from the sample on the path of spreading of evaporated cloud a Ni-foil was mounted for collection of condensing vapor products.

We have used two ordinary chondrites: Tsarev and Etter, and carbonaceous chondrite Allende. Meteorites are generally not homogeneous on a scale of millimeters. We tried to choose more or less homogeneous region on meteorite samples and performed vaporization from these places. To get more reliable data on the composition of the vaporized matter we performed some area (50x50 μm) measurements using SEM in the cross-sections under the melt of originated craters. Melt in the cross-sections of the craters was analyzed also using SEM technique. Condensate was analyzed using x-ray photo spectroscopy (XPS) technique.

Analyses of the condensates shows noticeable decrease in (Mg+Fe)/Si and Mg/Si ratios (see Table 1) compared to initial sample composition. The ratio (Mg+Fe)/Si is in the range 0.66-0.96. This result is in good agreement with our previous data on vaporization of olivine and serpentine [1] which indicated the pyroxene type of the forming condensate. The deconvolution of XPS spectra also shows that the condensates have [SiO₄]⁴⁻ polymerization mainly in chain structures. Mg is mainly

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bound in silicates. But Fe together with its incorporation into silicates also forms noticeable portions of metallic, sulfide, oxide and carbonate phases. In case of Etter, which was vaporized in different gas mixtures, there is a valid decrease in (Mg+Fe)/Si and Mg/Si ratios with complication of the gas environment what is not yet clear (Table 1).

Analyses of the melt shows the increase of (Mg+Fe)/Si and Mg/Si ratio to a certain degree in different parts of the melt depending on local volatilization efficiency (see Fig. 1,2). The range of Mg, Fe and Si concentrations in the melt drops well between olivine and pyroxene proportions. SEM analyses shows that Fe forms separate micron-size metallic spherules in the melt. Analyses

of Fe thus are representing only silicate part of the melt but not its bulk composition. Without account of metallic iron in the melt Fe is lacking since its concentration is decreasing in both melt and condensate. Ni is also well accumulated in metallic iron spherules. Melts are slightly enriched in Al and Ca showing usual refractory behavior of these elements.

REFERENCES: [1] Yu.P.Dikov, O.I.Yakovlev, M.V.Gerasimov, F.Wlotzka. In: Lunar and Planetary Sci. Conf. XXV, (abstr.), 1994, p.329. [2]] O.I.Yakovlev, Yu.P.Dikov, M.V.Gerasimov. Geokhimiya, 1995, No 8, p.1235 (in russian).

Table 1. (Mg+Fe)/Si and Mg/Si ratio in initial meteorites and in their condensates after high-temperature pulse vaporization in different atmospheres.

Sample	Atmosphere	(Mg+Fe)/Si		Mg/Si	
		Initial	Cond.	Initial	Cond.
Tsarev	He	1.97	0.82	1.16	0.56
Etter	He	2.39	0.96	1.40	0.67
Etter	CO ₂	2.39	0.86	1.40	0.47
Etter	CO ₂ +H ₂ O	2.39	0.66	1.40	0.40
Allende	CO ₂ +H ₂ O	2.92	0.83	1.44	0.48

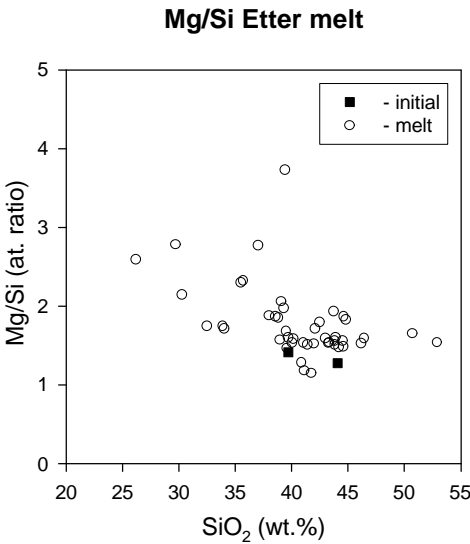


Fig. 1. Mg/Si ratio of the melt in experiment with Etter.

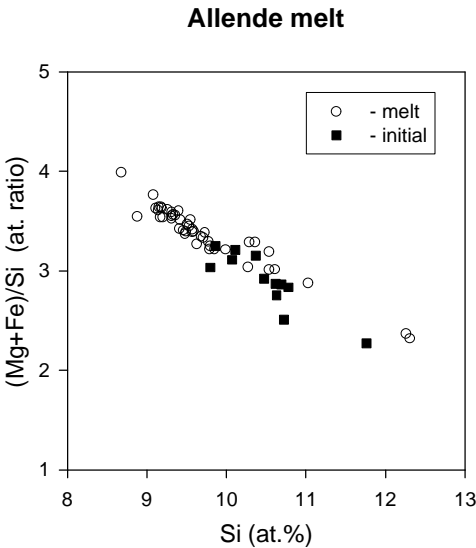


Fig. 2. (Mg+Fe)/Si ratio of the melt in experiment with Allende.